Laser Fluorometer for Remote Detection of Photosynthetic Life

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A laser fluorometer designed to characterize natural photosynthetic life has evolved over the years. The most current design of this fluorometer measures the quenching of the variable portion of chlorophyll fluorescence emission from the Photosystem II reaction center by the O_2-evolving enzyme, which allows distinction between O_2-producing versus anoxygenic phototrophs. Applications to the detection of cyanobacteria, diatoms and algae from hot springs, soda lakes, desiccated spores and lichens, as described in a companion poster (Dismukes et al.). Here we describe our existing spectrometer and its capabilities, with the aim of promoting its use in astrobiology research. A laser based fluorometer could be applied for remote sensing of photosynthesis from a rover on the surface of Mars, following field testing in the Atacama Desert and Antarctica. A remote-sensing laser fluorometer consist of three main parts: (1) laser diode for excitation, available wavelengths: blue, green red, near-IR, working in pulse mode from 1 to 1000 μs; (2) telescope and photodetector – avalanche photodiode with an array of interference filters working in photon counting mode; (3) data acquisition/control with ≥ 12 bits signal resolution and ≥ 20 Ms/s time resolution. This approach allows rejection of fluorescence signals from non-photosynthetic objects and by ambient light even in full sun light. Based on laboratory studies of cyanobacteria we estimate sensitivity for the remote laser instrument about 1 μg of chlorophyll at range 10 cm to 20 m. Energy consumption by parts (1) and (2) working in continuous regime is 0.2 W or less.